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Introduction: AI, Inclusion, and ‘Everyone Learning Everything’

Jeremy Knox, Yuchen Wang and Michael Gallagher

Keywords: Personalisation, Individualism, One-to-one tutoring, Special education, Community

1. Introduction

On the 16th of October 2018, the Parliament Education Committee in the UK hosted its first ‘non-human’ witness. A humanoid robot, developed by Softbank robotics and known as ‘Pepper’, was presented to the select committee by researchers from Middlesex University, with the intention of answering questions about ‘the Fourth Industrial Revolution and the implications for education of developments in artificial intelligence’ (UK Parliament 2018). While this highly-publicised event, in which the robot’s answers were pre-prepared, seemed to be more of a public relations exercise than a serious Parliamentary interrogation of intelligent machines, the session marked something of a significant achievement for raising the profile of *AI in Education* (see Luckin et al. 2016). Panel members also included (human) academics, students, and representatives from industry and charitable foundations, who supplied MPs with their views on the need for education to adapt to an era of increasing automation from AI. Indeed, the message appeared to be rather far-reaching, with all panel members supposedly agreeing that ‘the current educational system had to change drastically to accommodate the pace of technological change’ (Wakefield 2018). Significantly, the specific projects highlighted during the event related to ‘helping children with special needs improve their numeracy’ and ‘caring for older people’ (ibid.), positioning Pepper the robot in an assistive role, concerned with widening access and accommodating diverse groups of learners.

The cause of *Inclusive Education* has been promoted for some time, recently through the UN’s Sustainable Development Goal 4: to ‘ensure inclusive and equitable quality education and promote lifelong learning opportunities for all’. In the same year, UNESCO launched the *Incheon Declaration*, which provided a framework through which this goal might be realised by 2030. Participants at the accompanying *World Education Forum* included delegates from 160 countries, comprised of government ministers, representatives from various educational organisations, youth groups, and the private sector. The declaration extends the legacy of the worldwide movement ‘Education for All’, established through similar forums in Jomtien in 1990 and in Dakar in 2000, positioning the inclusive education agenda firmly within the realm of global politics.

Two high-profile visions for the future of education appear to be at work here, both seemingly concerned with what Friesen discusses, via the work of Johann Amos Comenius and Christoph Wulf, as the educational ‘dream’ of ‘everyone learning everything’ (forthcoming 2019: 2). The first promises to augment education with AI technologies that

provide new kinds of scientific precision in the analysis of educational activity - known as AIEd; 'giving us deeper, and more fine-grained understandings of how learning actually happens' (Luckin et al. 2016: 18). Importantly, this vision is often grounded in, and oriented towards, the idea of providing 'an intelligent, personal tutor for every learner' (Luckin et al. 2016, p24). The second, predominantly concerned with universal educational provision, presents 'a new vision' for education that is 'comprehensive, holistic, ambitious, aspirational and universal, and inspired by a vision of education that transforms the lives of individuals, communities and societies, leaving no one behind.' (UNESCO 2015: 24).

This book is motivated by an interest in the potential intersections, correspondences, divergences, and contestations between these future visions of 'quality education for everyone'. While there is a long-established field of research and development, not only in AIEd (see Luckin et al. 2016), but also in supportive and assistive technology (for example Edyburn et al. 2005), both the rise in popularity and ubiquity of techniques such as machine learning – often understood as 'the new AI' (Alpaydin 2016), and the growing awareness of the distinction of *inclusive* rather than *special* education, have suggested a very particular space of enquiry for which this book hopefully provides an engaging opening. Nevertheless, the apparent shared interests of AIEd and the inclusive education movement have not been lost on others concerned with educational futures. Houser (2017) suggests the former as a solution for the 'crisis' in education identified by the latter, where '[d]igital teachers wouldn't need days off and would never be late for work', and further, 'administrators wouldn't need to worry about paying digital teachers'. Given that UNESCO suggests a need to 'recruit 68.8 million teachers' (UIS 2016) in order to achieve the broad aims of inclusive and equitable education, one might therefore view AIEd, and its promise of personalised, one-to-one tuition, as a rather neat technical and cost-efficient fix, especially where resources seem to be increasingly limited for education systems under current global economic and political circumstances.

However, while both AIEd and inclusive education could be understood as sharing a vision of 'education for all', one might discern important differences, both in the means of achieving such a feat, as well as in the character of the education that is supposedly realised. Firstly, it might be pointed out that the UN and UNESCO's work are concerned with the

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overarching governance of educational development at a global scale, while AIED research and development tends to be more focused on context-specific pedagogical interventions and practices. Nevertheless, both these areas assume and convey a ‘worldview’ about education that is worth surfacing in this introduction. The definition of inclusive education tends to be considered in terms of educational practices that might be understood as expansive and embracing and concerned with the organisational and communal dimensions of education. In contrast, AIED is often grounded in a much more individualised view of the learning experience. This key distinction, between the attempts at *collective* educational work through inclusive pedagogies, and the drive for *personalised* learning through AIED, offer an important way of distinguishing these future visions of ‘everyone learning everything’. However, personalisation and inclusion are certainly not mutually exclusive conditions, as the various chapters in this volume will demonstrate. To help set the scene, the following section of this introduction will elaborate on one possible way of articulating this distinction, as a way of identifying some of the productive territory for critical research in this volume.

2. Personalised learning versus teaching for a ‘common ground’

A Nuffield Foundation report published this year on *Ethical and societal implications of algorithms, data, and artificial intelligence* identified ‘personalisation versus solidarity’ as a key ‘tension between values’ (Whittlestone et al. 2019: 20). This tension is apparent in the development of AI for inclusive education goals. A narrative of ‘personalisation’ often appears to drive AI research and development in education, in which ‘intelligent’, data-driven applications are employed to tailor educational content, or automate tutor feedback, for an individual student. There is certainly high-profile interest in this area, with figures such as Bill Gates investing significant funds for research and development (Newton 2016), and Facebook developing ‘Personalized Learning Plan’ software, initially with a school network in California, but also with national ambitions (Herold 2016). Predictions for the success of such systems, and claims about the need to restructure the role of the (human) teacher are rife. Notable here is the common interest in perceiving AI not just as replicating the role of teacher or tutor, but also as producing a kind of ultimate pedagogue that provides an advanced and elite form of education. For example, Sir Anthony Seldon’s recently predictions for educational AI included ‘the possibility of an Eton or Wellington education for all’ in which ‘everyone can have the very best teacher’ enabled through ‘adaptive machines that adapt to individuals’ (von Radowitz 2017). This notion also appears to have significant influence at the educational publisher Pearson, where the director of artificial intelligence Milena Marinova portrays an idealised world in which ‘every student would have that Aristotle tutor, that one-on-one, and every teacher would know everything there is to know about every subject’ (see Olson 2018). Media reporting seems particularly keen to

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publicise cases of AI tuition. ‘Jill Watson’ is one such example, developed by Professor Ashok Goel, about which media reports consistently emphasised the idea that it was indistinguishable from a human teacher (Hill 2016; Leopold 2016).

While such efforts to envision and develop a supreme ‘AI tutor’ may represent far more serious endeavours than Pepper the robot visiting the UK Parliament, there appear to be a number of questionable assumptions underpinning the quest for machine-driven personalisation. As Friesen (forthcoming 2019) demonstrates, there is a long history, and orthodoxy, to the idea of the personalised tutor, which, through the promise of AIED, manifests as part of the contemporary ‘technological imaginary’:

The vision for the future that these technologies promise to fulfil, moreover, could not be any more total: Their global availability to every man, woman and child, and for any topic that they might wish to learn. (ibid.: 2)

While such ambitions might sound rather appealing to those interested in realising the goal of an inclusive educational system, Friesen (ibid.) highlights the underlying ‘mythology’ of this imagined future, involving the establishment of the primal value of the one-to-one pedagogical relationship, as well as the idea that computers are able to simulate it. Rather than innovation, this constitutes a ‘a kind of repetitive continuity that educational innovators generally see themselves as leaving behind’ (ibid.: 4). Importantly, what Friesen suggests is that the ideal of one-to-one tuition is much better understood through the parables and allegories offered by the likes of Socrates (through Plato and Xenophon), Comenius, and Rousseau, rather than through the scientific precision of the Enlightenment, and the engineering disciplines of computer science that followed it. For Friesen, ‘[d]ialogue, in short, is a ubiquitous yet irreducible experience’ (ibid.: 12). Here, then, the reproduction of educational activity within rational, technical systems becomes something much more akin to a regime of control than a culture of inclusion. As Friesen suggests:

for education or any other aspect of social activity to fall so completely under the dominance of a total vision of social and technical engineering would be “totalitarian” in and of itself (ibid.: 13).

Speculations on the role of the teacher in the era of artificial intelligence feature throughout this volume. Michael Rowe’s chapter discusses the increasing power of machine learning techniques employed for teaching purposes and reflects on the extent to which teacherly activity can be replaced by ‘brute force computation’ (p142). Alex Guilherme’s chapter also engages directly with the questions around teacher replacement, developing the concept of *Bildung* as a way of understanding the differences in human and machine capabilities in education. This volume also includes research of ‘pedagogical agents’, examined in the chapter from Maggi Savin-Baden, Roy Bhakta, Victoria Mason-Robbie and

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David Burden. Here the effectiveness of adaptive tutoring software is measured against aspects of ‘human’ teaching. Emphasising this idea of AI in a supporting role, Kaška Porayska-Pomsta and Gnanathusharan Rajendran also examine the use of ‘AI agents’ to augment specific teaching scenarios. While authors in this volume consistently argue against the notion of AI straightforwardly replacing (human) teachers, we are certainly reminded of the importance of practitioners’ active participation in the decision-making processes of AI development, and the necessity of establishing standards that might promote inclusion, perhaps in a very similar way to the training of human teachers and regulation of professional teaching conduct.

The utopian technological vision of personalisation, while perhaps grounded in the myth of the authentic educational dialogue, also appears to align rather seamlessly with contemporary views of ‘learner-centred’ education. AI systems that purportedly support one-to-one tutoring from human teachers, such as the Carnegie Learning¹ or Third Space Learning² platforms, function through analysing learner behaviours and providing real-time feedback from student activities. AI, here in a supporting role, provides value through its ability to observe, and ‘know’, students’ learning behaviour in forensic detail. Whether through adaptive software, or overt AI tutoring systems, work in AIED is often premised upon a tacit assumption that education is at its best when it is developed around, and in response to, an individual student, who is understood to already possess particular abilities, proclivities, or desires in relation to the learning process. In other words, AI-driven ‘personalisation’ not only views the individual as the key source of information on how to structure and organise educational activity, but also positions education as ultimately subservient to a notion of innate human characteristics, rendered discoverable through ever-expansive data capture practices. This orientation tends not only to view student behaviour as the decisive factor in determining the action of the teacher, but also to restructure educational activity around the idea of the *personal*. Thus the ‘learnification’ of education (see Biesta 2005; 2006; 2012), as part of a broad societal shift towards the individual, achieves a particular intensity through data-driven educational technologies (Knox et al. forthcoming 2019). Indeed, as Knox et al. (ibid.) discuss, through the training of machine learning systems and the use of nudging techniques in educational software, the domain of learning appears to offer *less* opportunities for participation and agency, while, somewhat incongruously, maintaining a core rationale of ‘student-centred’ design and learner empowerment.

In contrast to the tendencies towards ‘personalisation’ in AI, inclusive education offers some potentially different directions for thinking about educational activity. Inclusive education is, on the one hand, driven by the idea of an individuals’ rights to education and development, and on the other hand, also presented as a response to the challenges faced by many educators in different parts of the world, where learning communities have become

¹ see <https://www.carnegielearning.com/>

² see <https://thirdspacelearning.com/how-it-works/>

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increasingly diverse and less homogeneous. However, the definition of inclusive education can be highly contested and ambiguous (Slee 2011). The term is often closely associated with the idea of removing barriers to learning for groups who are vulnerable to marginalisation and exclusion, and concerns attempts to ensure all learners' participation regardless of their individual differences (Florian 2008). Importantly, the process of achieving inclusive education is never straightforward, and can involve endless negotiations among stakeholders and continual pedagogical decisions within specific educational environments. It is also productive, therefore, to view inclusion as political. In critiquing the broad shifts towards personalised forms of education, Ginsburg questions 'to what extent attempts to promote active, collective, and democratic forms of citizen participation are possible within the discursive framework of personalisation' (Ginsburg 2012: px).

While at a glance, providing individualised support might seem to offer a kind of inclusion. Indeed, *special* support for those perceived to be *different* has been the rationale for special education – a more traditional disciplinary response to learning differences. However, recent research on inclusive pedagogy has stressed the limitation of special educational thinking, while arguing for the need to extend what is generally available to *all* learners (Florian 2008). Interestingly, when we consider the context of (human) teaching and learning in mainstream educational settings, inclusion is approached by developing a 'common ground' within educational activities. Rather than solely developing a one-on-one relationship between the teacher and the student, inclusive education attempts to generate the many-to-many kind of communal dialogue that authentically fosters equality within a group of learners. Inclusion, in this sense, is about staying 'within the trouble', and perhaps the 'messiness', of difference and diversity in educational settings, and viewing such a balancing act as a pedagogical ideal, rather than as a practice of excess and superfluity to be excised through efficiency measures. At the heart of inclusive pedagogy, therefore, is a notion of what is valued by the community, rather than a focus on individual achievement. For UNESCO, while an economic rationale for education is nevertheless apparent, inclusive practice 'goes beyond a utilitarian approach to education and integrates the multiple dimensions of human existence' (UNESCO 2015: 26).

This broad and idealistic view of inclusive education has tended to eschew specific engagement with questions around the use of technology. However, research and development in assistive technology has long sought to provide specialist support, and AIED itself is often suggested to be

'not just more personalised, but also more inclusive and engaging. For example, they can provide additional help for learners with special educational needs, motivate learners who cannot attend school, and support disadvantaged populations.' (Luckin et al. 2016: 30)

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As Anna Wood's chapter demonstrates with respect to chronic illnesses, this approach has been productive and helpful for many in terms of assisting with everyday working practices. However, limitations are also encountered, as reflected by the child participants in Sophia Serholt's chapter, when the presence of technology is perceived as an all-encompassing solution without considering its dynamic, interactive, and agential role within educational environments. As pointed out by several authors in this volume, to make AI technologies work for inclusive education, it is essential to re-examine what data are being gathered for the training of such systems: are the data inclusive enough to represent all groups of learners? However, one should also view the challenge of inclusive education in terms of curricula, not just the application of technology, which may only amplify learning material that is outdated or biased. Further, AI technologies are put to work within wider, and inevitably exclusionary educational systems driven by an agenda of performance (Wang, 2016), and such conditions would only be intensified by data-driven technologies. In other words, the challenge of inclusion lies within society, and cannot necessarily be 'fixed' with a technical solution. The usage of AI may instead aggravate other forms of injustice. For example, wealthy learners might take advantage of the ability to purchase AI tutoring services from private developers, and regions with more advanced digital infrastructure, or learners already equipped with better digital skills, might also benefit more from the availability of such technologies. Michael Gallagher's chapter discusses this 'Matthew Effect' in the context of the mobile technologies increasingly involved in AI.

We suggest that one of the key purposes of this book is to engage researchers and teachers who tend to consider their work with inclusion to be exclusively about human relationships, within physical classrooms. We hope that the following chapters offer critical views of AI that counter the assumption that one either engages with technology, or not, or that technology is simply an 'add-on' to core humanistic pedagogies. As readers will encounter in the following work, the issues surfaced by ever more pervasive AI systems in education have profound consequences for all kinds of educational endeavours, and particularly for those concerned with understanding how commonality, inclusion, and exclusion manifest through the structural arrangements of pedagogy. We invite you to join this very important conversation regarding the future of education and continue to discuss the remaining unspoken issues beyond the scope of this volume.

3. Artificial Intelligence and inclusive education - speculative futures and emerging practices

The various contributions in this book offer a rich view, not only of research and development that attempts to engage with the intricate intersection of ideas across 'AI' and 'inclusion', but also of the terms themselves. As editors, we chose not to prescribe the use of these terms too rigidly, with the idea that authors might surface a range of perspectives and

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understandings, linked to the specific contexts of their research and practice. This final part of the introduction will outline the various ways ‘AI’ and ‘inclusion’ have been interpreted throughout the book, as a way of summarising the contributions made by each chapter.

Firstly, this book began with the understanding that the term ‘AI’ serves as a fairly loose umbrella term for a wide range of concepts, practices, and technologies. This is seen particularly productive, as the authors are able to bring together and demonstrate a broad range of educational work with AI, and offer informed speculation on critical issues and future developments. The chapters from Phaedra S. Mohammed and Nell Watson, and Gunay Kazimzade, Yasmin Patzer, and Niels Pinkwart provide useful general overviews of a range of AI for education approaches and technologies. The former focuses on ‘intelligent learning environments’ (ILEs), while the latter links more established work in assistive technology with emerging AI developments. Maggi Savin-Baden, Roy Bhakta, Victoria Mason-Robbie and David Burden offer a more focused study, examining and measuring the effectiveness of ‘pedagogical agents’ capable of assisting with mathematics tuition. Kaśka Porayska-Pomsta and Gnanathusharan Rajendran describe ‘AI agents’, in one case specifically developed to teach children with Autism Spectrum Disorders, in which a human teacher’s ordinary teaching method might be considered less effective. Anna Wood’s chapter reflects on technology related to assisting those with chronic illness, and outlines a number of real and speculative AI technologies capable of responding to a range of needs. AI is also often associated with hardware, and the chapters from Sofia Serholt, and Seungcheol Austin Lee and Yuhua (Jake) Liang offer their perspectives on that most familiar of AI manifestations, the *robot*.

Theoretical discussions of AI are also represented. Michael Rowe focuses on ‘algorithms’, which, as an important technical component of machine learning AI approaches, offers an insightful way of understanding the socio-technical relations that connect educational activity to technological production. Alex Guilherme considers ‘intelligent tutoring systems’, and relates this educational concern with broader debates around so-called ‘weak’ and ‘strong’ AI. Rather than discussing specific AI technology, Michael Gallagher analyses the ‘mobile ecosystems’ in which machine learning increasingly functions, and through which issues of accumulated advantage take place, offering important speculation on future inclusions and exclusions in education. The final chapter from Michael A. Peters and Petar Jandrić presents further speculation on the future of AI, and its relationship with ideas of human evolution, and the development of ‘algorithmic non-carbon-based ‘living’ systems’.

Secondly, this book began with a broad view of inclusion – a notion of quality education for everyone regardless of individual differences - in order to encourage authors’ creative and critical engagement with these ideas. In this final section of the introduction, we see value in clarifying, from our editorial perspective, how each chapter in turn has interpreted and engaged with the idea of inclusion in the context of AI technologies.

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Phaedra S. Mohammed's and Nell Watson's chapter, *Towards Inclusive Education in the Age of Artificial Intelligence: Perspectives, Challenges, and Opportunities*, makes an important case for considering the cultural inclusions and exclusions related to various AI systems and technologies. This chapter calls for an interdisciplinary approach, incorporating insights from cultural anthropology, sociocultural linguistics, and educational psychology, to broaden the understanding of the specific contexts into which AI are applied.

Kaśka Porayska-Pomsta and Gnanathusharan Rajendran's chapter - *Accountability in human and artificial decision-making as the basis for diversity and educational inclusion* - adopts AI as a conceptual framework to rethink learning and inclusion. They provide examples of AI software for contexts in which human teaching might be viewed as challenging, if not a hindrance and a limitation: the teaching of children with Autism Spectrum Disorders. Here the replacement of the human teacher might be seen as a necessity, rather than an efficiency measure. However, Porayska-Pomsta's and Rajendran's chapter also highlights the issue of accountability in AI, which frames inclusion in terms of the accessibility of the technology, calls for more human agency in developing socially just and inclusive technologies. This is a key aspect of the intersection we attempted to explore in this volume, and is also discussed in Michael Rowe's chapter (see below).

Gunay Kazimzade, Yasmin Patzer, and Niels Pinkwart's chapter - *Artificial Intelligence in Education meets inclusive educational technology: the technical state-of-art and possible directions* - includes a wide focus on various inclusion issues, such as the way specific AI systems exclude those with physical disabilities, and examples of cultural exclusions. They ask critical questions about what kind of data models underpin AI systems, for instance, data from users with impairments that might appear to be 'irregular', and thus likely to be dismissed. This highlights the extent to which inclusion issues can be addressed through additions and refinements in the development of AI itself.

Sofia Serholt's work with robots, discussed in her chapter, *Interactions with an Empathic Robot Tutor in Education: Students' Perceptions Three Years Later*, offers the interesting possibility of moving away from the more typical uses of AI for performative assessments of individual students. This chapter provides a glimpse of AI technology utilised for the social and relational aspects of pedagogy that are the hallmarks of inclusion. One might usefully read Michael Rowe's and Alex Guilherme's chapters alongside this work to explore possible limitations to these ideas, however. Particularly valuable in Serholt's chapter are the insights from children related to the ways robots are perceived by those on the receiving end, and how special assistance through technology may generate experiences of isolation if used without the consideration of group dynamics in a classroom.

Seungcheol Austin Lee and Yuhua (Jake) Liang make useful connections between inclusive practice and the notion of 'trust'. This chapter, entitled *A Communication Model of Human-Robot Trust Development for Inclusive Education*, offers interesting ways for AI to develop towards classroom presence. It considers the reality of interactions that take place in classroom settings, and offers ideas about how one could possibly make better use of AI in

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daily practice for educational ends. In addition, the chapter also points out how certain groups of learners might be disadvantaged in the era of AI, resulting from apprehension towards technology development.

In their chapter *An evaluation of the effectiveness of using pedagogical agents for teaching in inclusive ways*, Maggi Savin-Baden, Roy Bhakta, Victoria Mason-Robbie and David Burden examine the ways specific AI technology can support diverse learners, focusing on the idea of personalised pedagogy. This chapter makes a case for the accuracy of technology in teaching scenarios, and calls into question the assumption that a human teacher is always superior. Importantly, inclusion issues are identified in the training of AI systems through the use of specific datasets, highlighting the need to take seriously of teacher education, whether involving humans or machines. This chapter also emphasises the benefits resulting from learners reflecting their own learning strategies through AI software, and the potential advantages for increased engagement with education as an outcome.

Anna Wood's chapter, *Inclusive Education for Students with Chronic Illness - Technological Challenges and Opportunities*, focuses on one group of atypical learners as a key example of the potential liberating, but also limiting, capacities of AI technologies. This specific view of the particular needs of those with chronic illnesses highlights the complex barriers to participating in everyday work-based activities, often involving individual's physical bodies. Importantly, this chapter connects specific inclusion concerns to a broader political sphere, through which access to resources are governed.

Michael Rowe's chapter, *Shaping our algorithms before they shape us*, foregrounds an important call for a development of AI technology that is inclusive, in particular, to involve teachers as key agents in the decision-making process. This is a valuable critical interpretation of inclusion that offers an alternative to the dominance of the tech industry in the production of educational technology. For Rowe, human teachers provide a crucial means of contesting the deterministic outcomes of algorithmic decision-making. Moreover, the critical discussion of the instrumentality of algorithms in this chapter also highlights the increasing datafication and performativity of the sector, within which professional teachers, and students, are both reduced to 'cheerful robots' (Giroux 2011: 3). Ultimately, Rowe's framing of AI in education as a social and pedagogical problem, rather than simply a technical one, should resonate with educators concerned with instilling inclusive practices, and resisting neoliberal models of the institution.

Alex Guilherme's chapter, *Considering AI in Education: Erziehung but never Bildung*, focuses on the relationships between people in educational activity, and this aligns with key practical aspects of the inclusive education agenda. Rather than assuming technology as a quick fix for educational dilemmas, this chapter asks important questions about future directions for inclusive education development – what will happen when technology potentially disrupts our (human) relationships within an educational community?

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It is thus very ironic, given that relationships are something very important in education, that the impact of the technologisation of education and its potential depersonalisation of the classroom is not discussed in more detail and philosophically questioned (p. 154).

Guilherme's call for 'real dialogue' (p. 157) with students, but also an education that moves beyond the acquisition of skills, surfaces important social and political dimensions of inclusive practice, and highlights important aspects of learning to live collectively through education.

Michael Gallagher's chapter, *Artificial intelligence and the mobilities of inclusion: the accumulated advantages of 5G networks, machine learning, and surfacing outliers*, highlights the accessibility of technology, surfacing important questions about those with and without the skills to make use of it effectively. For Gallagher, such issues must be addressed before the benefits of deployed AI can be realised. This chapter also questions reductionist views of education engineered through AI, 'as curricula [are] being aligned to largely derivative computational models of learning' (p. 171). The work of inclusion instead requires us to grapple with the complexity of educational process when diverse learners learn together.

Embracing the speculative approach suggested by this book, Michael A. Peters and Petar Jandrić present some useful alternatives to established notions of inclusion. The chapter, *Artificial Intelligence, Human Evolution, and the Speed of Learning*, bypasses the humanism that governs most understanding of inclusive education, and poses intriguing questions about how we might categorise both humans and machines in the future. As Peters and Jandrić discuss, where AI development and human genetic research are increasingly interconnected, the boundaries become increasingly blurred, and the concept of educational equality may need considerable reinvention.

References

- Edyburn, D., Higgins, K., and Boone, R. (2005) *Handbook of Special Education Technology Research and Practice*. Knowledge By Design, Inc; Oviedo
- Florian, L. (2008) Special or inclusive education: future trends. *British Journal of Special Education*, 35(4): 202-208.
- Ginsburg, M. (2012) Personalisation is Political, But What Kind of Politics? In Monica E. Mincu (Ed.), *Personalisation of Education in Contexts: Policy Critique and Theories of Personal Improvement*, Foreword.
- Giroux, H. (2011) *On Critical Pedagogy*. Continuum. The Continuum International Publishing Group Ltd., London.
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- Herold, B. (2016) Facebook's Zuckerberg to Bet Big on Personalized Learning. *Education Week*. Available: <https://www.edweek.org/ew/articles/2016/03/07/facebooks-zuckerberg-to-bet-big-on-personalized.html>
- Hill, D. (2016) AI Teaching Assistant Helped Students Online—and No One Knew the Difference. *Singularity Hub*. Available: <https://singularityhub.com/2016/05/11/ai-teaching-assistant-helped-students-online-and-no-one-knew-the-difference/#sm.0001x3wextuewdw0112hplwa2e8bh>
- Leopold, T. (2016) A Secret Ops AI Aims to Save Education. *Wired*. Available: <https://www.wired.com/2016/12/a-secret-ops-ai-aims-to-save-education/>
- Luckin, R., Holmes, W., Griffiths, M., Forcier, L.B. (2016) Intelligence Unleashed An argument for AI in Education. Pearson Report. Available: <https://static.googleusercontent.com/media/edu.google.com/en//pdfs/Intelligence-Unleashed-Publication.pdf>
- Newton, C. (2016) Can AI fix education? We asked Bill Gates. *The Verge*. <https://www.theverge.com/2016/4/25/11492102/bill-gates-interview-education-software-artificial-intelligence>
- Olson, P. (2018) Building Brains: How Pearson Plans To Automate Education With AI. *Forbes*. <https://www.forbes.com/sites/parmyolson/2018/08/29/pearson-education-ai/#47c32cf41833>
- Peters, M. (2012) Personalisation, Personalised Learning and the Reform of Social Policy: prospects for molecular governance in the digitised society. In Monica E. Mincu (Ed.), *Personalisation of Education in Contexts: Policy Critique and Theories of Personal Improvement*, pp. 89–106.
- Slee, R. (2011) *The irregular school: Exclusion, schooling, and inclusive education*. London: Routledge.
- UNESCO. (2015) Education 2030: Incheon Declaration and Framework for Action for the implementation of Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning. Available: <https://unesdoc.unesco.org/ark:/48223/pf0000245656>
- UIS. (2016) The World Needs Almost 69 Million New Teachers To Reach The 2030 Education Goals UNESCO Institute for Statistics. Available: <http://uis.unesco.org/sites/default/files/documents/fs39-the-world-needs-almost-69-million-new-teachers-to-reach-the-2030-education-goals-2016-en.pdf>
- von Radowitz, J. (2017) Intelligent machines will replace teachers within 10 years, leading public school headteacher predicts. *The Independent*. Available: <https://www.independent.co.uk/news/education/education-news/intelligent-machines-replace-teachers-classroom-10-years-ai-robots-sir-anthony-sheldon-wellington-a7939931.html>
- Wakefield, J. (2018) Robot 'talks' to MPs about future of AI in the classroom. BBC News, Technology section. <https://www.bbc.co.uk/news/technology-45879961>
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- Wang, Y. 2016. Imagining inclusive schooling: an ethnographic inquiry into disabled children's learning and participation in regular schools in Shanghai. Phd thesis. Edinburgh: University of Edinburgh.
- Whittlestone, J., Nyrop, R., Alexandrova, A., Dihal, K and Cave, S. (2019) Ethical and societal implications of algorithms, data, and artificial intelligence: a roadmap for research. Nuffield report. Available:
<http://www.nuffieldfoundation.org/sites/default/files/files/Ethical-and-Societal-Implications-of-Data-and-AI-report-Nuffield-Foundat.pdf>
- UK Parliament. (2018) October 12th Pepper the robot appears before Education Committee
<https://www.parliament.uk/business/committees/committees-a-z/commons-select/education-committee/news-parliament-2017/fourth-industrial-revolution-pepper-robot-evidence-17-19/>

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